DESIGN OF MULTIMODAL BIOMETRIC SYSTEM FOR PERSONAL AUTHENTICATION

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ABSTRACT

Unimodal biometric systems have to be contend with a variety of problems such as noisy data, intra-class variations, restricted degrees of freedom, non-universality, spoof attacks, and unacceptable error rates. Some of these limitations can be addressed by deploying *multimodal biometric systems* that integrate the evidence presented by multiple sources of information. In this proposed work, we choose palm print and palm vein as object of recognition. It is a new approach for the personal identification using hand images that is presented by using palm print and palm veins. This study attempts to develop reliable multimodal biometric systems in order to enhance the security and eliminate problems in personal identification systems with high recognition rate.

INTRODUCTION

Personal identification technology is applicable to various systems including area-access control, PC login, and e-commerce. Identity can be defined as characteristics, signs, or attributes attached to someone that distinguishes him from the others, both physical and non-physical [1]. Several types of techniques have been used for finding the uniqueness of individuals. These techniques are like fingerprints, palm prints, finger veins, hand veins, face veins, palm veins, face shapes, palates, iris, DNA recognition, facial expression, gait signature, voice recognition, body language, heartbeat and foot veins etc [2]. Recognizing the identity of a person with high confidence is a critical issue in various applications, such as e-banking, access control, passenger clearance, etc. The need for reliable user authentication techniques has significantly increased in the wake of heightened concerns about security and rapid advancement in networking, communication, and mobility [4]. Biometrics is considered as a currently ongoing scientific research topic with many applications, regarding safety and convenience [4]. Research on biometrics continues to grow. Various studies conducted to increase the performance of personal identification based on physical and

behavioral characteristics [3]. Biometric systems deal with automated algorithms of identifying a person as an authorized user of a system based on physical characteristics such as iris, retinal, face, hand geometry, face and vein [5]. As a reliable and robust biological characteristic, the vein pattern increases more and more the progress in biometric researchers [6]. Multi-model biometric systems are gaining acceptance due to performance superiority over uni-modal systems which are limited as regards with accuracy, processing time and vulnerability to spoofing [6]. Multimodal Biometrics is a combination of more than one biometric trait. As compared to unimodal biometrics multimodal biometrics are more reliable as multiple traits are used. Multimodal Biometrics reduces FAR (False Acceptance Rate) error rate. Multimodal biometric systems are more secure as it becomes difficult for an intruder to copy multiple biometric traits of a user, the hence more secure system is achieved [5].

REVIEW ON RELATED WORK

Sen Lin et al [11] studied the ROI extraction method for palm print and palm vein recognition. In their studies, firstly, the preprocessing operation of palmprint and palm vein is carried out by using binary and morphological denoising technology, then the ROI regions are located and extracted based on the maximum inscribed circle and centroid methods. Finally, the algorithms are tested on PUT palm vein database and CASIA database. The experimental results show that the methods of their study have a good effect, which is feasibility and validity. Furthermore, an online ROI extraction simulation system is designed in this article. The palmprint or palm vein image can be obtained in real-time by using the camera through the system, then the ROI can be extracted. The simulation system is intuitive and easy to operate, which provides a reliable experimental platform for the study of palmprint and palm vein recognition technology.

Li Peidan et al [13] designed an embedded multimodal palm biometric system using Exynos5410 platform. Feature extraction is accomplished using Non-Halo Complex Matched Filtering (NH-CMF) approach, enhance the system anti-spoof by integrating the palm print with palm vein, and at the same time improve system

matching accuracy of EER of 15.25 % and a verification processing time of 0.7 seconds. When implementing the system on Exynos5410, Cortex-A15 processor with powerful operation capability is employed to concentrate on the complicated feature extraction operation, and the Cortex-A7 processor is engaged in peripheral control, task scheduling and user interaction. Person's palm print and palm vein images are captured, then system extracts biometric data, encrypts it, and prepares for comparison. The comparison of the biometric data is performed on smart card for additional security.

Dipali Patalau Gaikwad et al [8] proposed algorithm captures local minutiae and a global feature from a palm print and palm vein images and stores them as a compact code. After extraction of the ROI from the source images the (2-D) image spectrum is divided into fine sub-components (called subbands) using iterated directional filter bank structure. The feature matching technique is then performed using Euclidean Distance algorithm. For this algorithm, CASIA Palmprint Database V1.0 is used.

Mr. Aditya Gupta et al [12] proposed a multimodal biometric system using face modality combined with palm print and palm vein modality. Their proposed methodology uses Local Statistical method in which pre-defined block of DCT coefficient was used to calculate the standard deviation and store them as a feature vector. Matching is done using distance between the feature vector of testing and training data set. The results showed that the Genuine Acceptance Rate (GAR) of feature level fusion is 100% which is better than, that of uni-modal systems, hence having multimodality is advantageous. For testing and training database of 100 students of College of Engineering Pune.

OVERVIEW

The international standard organization (ISO) has defined the meaning of “biometric”. The term “biometric” is a combination of two Greek words: one is „bio‟ which means „Life‟ and the other is „metric‟ which means „Measurement‟ [2]. In general terms, biometrics can be stated as the process or technology by which an individual’s physical and physiological and behavioral traits are obtained and then recorded by an electronic device. These recorded traits are later used for identification and authorization purposes. It is one of the most popular and accurate authentication techniques.

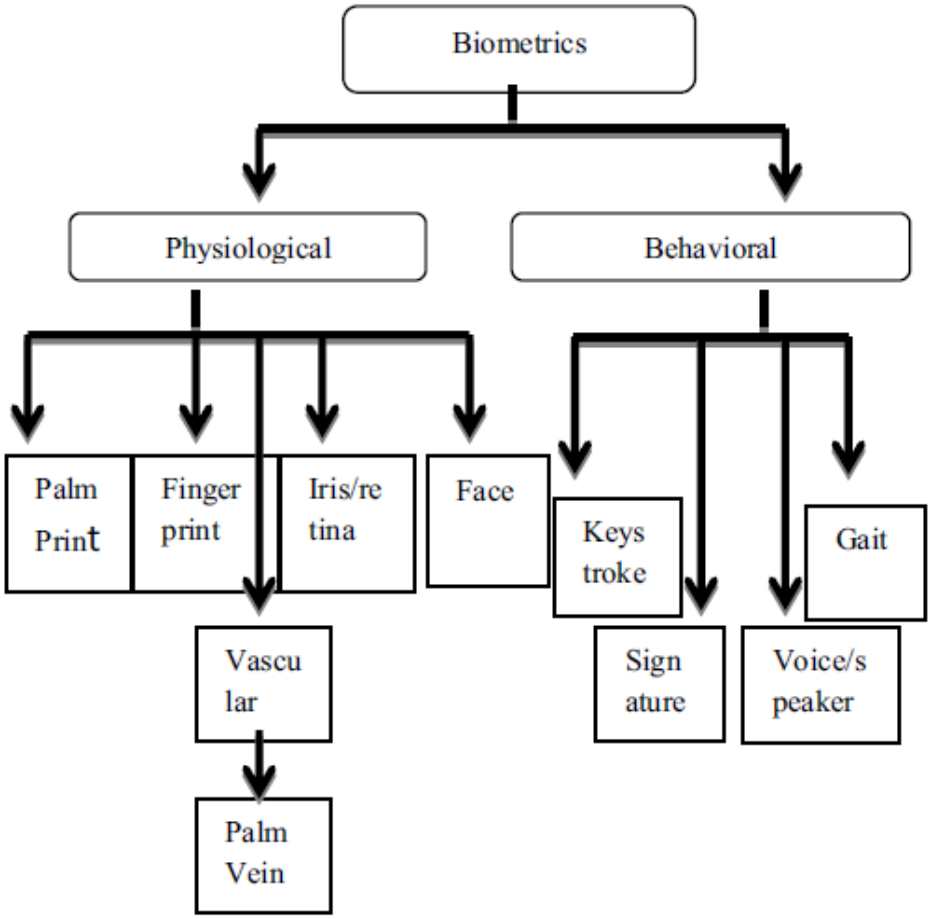

Figure 1 shows the biometric system hierarchy

A number of biometrics characteristics have been proposed till date. Broadly they can be categorized into two major groups physical and behavioral characteristics. *Examples of physical characteristics*: fingerprint/palm-print recognition, face recognition, iris, retinal, voice recognition, finger/hand/palm vein recognition. *Behavioral characteristics*: walking gait, signature dynamics, handwriting and voice [6]. A biometric system is essentially a pattern recognition system which recognizes a user by determining the authenticity of a specific anatomical or behavioral characteristic possessed by the user [4].Thus biometric technique allows us to identify individuals automatically on the basis of their physiological and behavioral features [2]. Biometric-based systems have been developed with various modal, such as fingerprints, iris, palm prints, palm vein, and many others [1]. Most of the biometric ystems deployed in real-world applications are unimodal which rely on the evidence of the single source of information for authentication (e.g., fingerprint, face, voice, palmprint, Finger Knuckle Print (FKP) etc.,).

Biometric systems are being deployed to enhance security and reduce financial fraud.

In some applications, more than one biometric trait is used to attain higher security and to handle failure to enroll situations for some users. Such systems are called multimodal biometric systems [4]. Security is the main concern in Automated Teller Machines today. Multimodal Biometrics are more secure as compared to Unimodal Biometrics as even if one trait fails the other is present. The futuristic application of Multimodal Biometrics could be in Automated Teller Machines (ATM) [6]. Multimodal biometric systems represent two/more combined biometric recognition technologies. They ensure higher security as more than one identity indicator is requested from users making it hard for intruders to fool systems as many fake identities would be needed simultaneously [5].

Multi-modal biometric recognition systems have greater advantages over traditional systems that are:

- difficult to break and
- provide good anti-spoofing abilities.

Use of these systems has increased in recent years owing to the increasing trend of thefts, breaking of security systems, hacking and another means of unauthorized access [5].

unimodal biometric systems present some limitations such as:

- Noise in captured data.
- Intra-class variations and inter-class similarities.
- Non-universality.
- Inter-operability issues.
- Spoof attack performance and fraud. [6].

Some of the limitations imposed by unimodal biometric systems can be overcome by including multiple sources of information for establishing identity. These systems allow the integration of two or more types of biometric systems known as multimodal biometric systems. These systems are more reliable due to the presence of multiple, independent biometrics [4].

Many factors are to be deliberated when designing multimodal biometric systems:

(1) nature and number of traits
(2) the level at which information provided by biometric traits is integrated
(3) method to integrate information
(4) the relationship between cost and performance.

A multimodal system operates in one of three different modes: serial, parallel or hierarchical mode.

- *In serial* mode, the output of one modality narrows down a number of possible identities before next modality is used. Hence, multiple sources of information (multiple traits) need not be acquired simultaneously. Also, a decision can be made before acquiring all traits which reduce overall recognition time.

- *In parallel* mode, information from multiple modalities is used simultaneously to perform recognition.
- *In hierarchical* schemes, individual classifiers are combined in a treelike structure and this mode is relevant when classifiers are many [6].

Personal identification using physiological traits or behavior characteristics, namely, biometrics, is becoming a new substitution of traditional identification technics. It provides higher security, reliability, and convenience. Biometrics have already been used to a wide range of security systems and share more and more of the personal identification market.

Physiological traits used for identification include fingerprint, iris, face, palmprint, vein, etc. Personal identification systems based on any of the above traits are widely studied recently, and some of them gain considerable results. But the performance of a biometric system can be easily affected by the reliability of the sensor or the environment.

This problem can be addressed by using multiple sensors, each of which captures a unique trait. Such systems, known as multi-modal biometric systems, are expected to be more reliable and attract more research interests.

Human identity recognition is intended for many purposes, one of them is for security system along with the development of technology in various business sectors such as transportation, trading, agriculture, and demography.

People use many ways to represent their authorities, like the electronic card (smart card), password (password), PIN numbers, token, and QR code. However, those objects that are commonly used still have many shortcomings and risks. For instance, it can easily be stolen, forgotten, forged, lost or damaged. Practically it does not really represent a person's identity or “who you are”, but simply “what you have” or “what do you remember”. Therefore, a system namely biometric that can represent person’s authority using biological representation has been developed

recently. The system identifies objects that are uniquely owned by each person. They can hardly be transferred, stolen, or delegated by someone else [1].

Vein recognition system originates from the idea that human can be characterized by its vast vein network pattern that is hidden under the skin. Even though vein images can be assessed through any areas in the human body, the hand is considered as the most convenient part for this purpose.

Palm vein pattern recognition is one of the newest biometric techniques researched today.The vein information is hard to duplicate since veins are internal to the human body [10].

BACKGROUND OF PALMPRINT BASED SYSTEMS

Palm print recognition has emerged as a highly accepted biometric system due to its easy acquisition and reliability. Palm is the inner surface of hand between wrist and fingers. The inner surface of palm contains three flexion creases, secondary creases, and ridges for each finger. The flexion is also called as principal lines and secondary creases are called wrinkles. Palm feature also includes singular points, ridges, wrinkles, and delta, datum and minutiae points. Palm features are unique for every individual and have rich information that can be used for feature extraction. The palm lines and wrinkles are formed during the third and fifth month of the formation of the fetus. The wrinkles, ridges, principal lines namely heart lines, headlines; lifelines are shown in the fig. 2. A region of interest (ROI) is extracted from the palm area for processing. Palm recognition process includes feature extraction (stored as a template in the database) matching (input query features are matched with stored features) and decision making (to accept or reject the query based on match score).

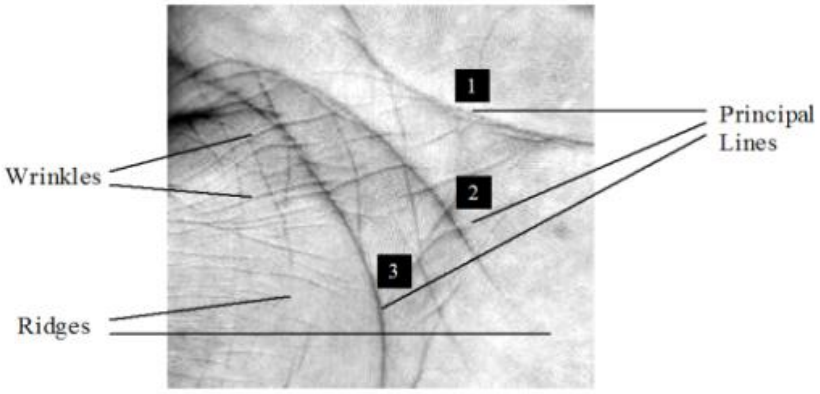

Figure 2: Palm features

A biometric system which uses a palm print of a person for authentication/verification is shown in fig 3. The processing level includes image acquisition level, feature extraction level, match score level and decision level. The basic level of processing is same for all the biometric system. The complexity lies in the implementation of processing using different approaches and methods.

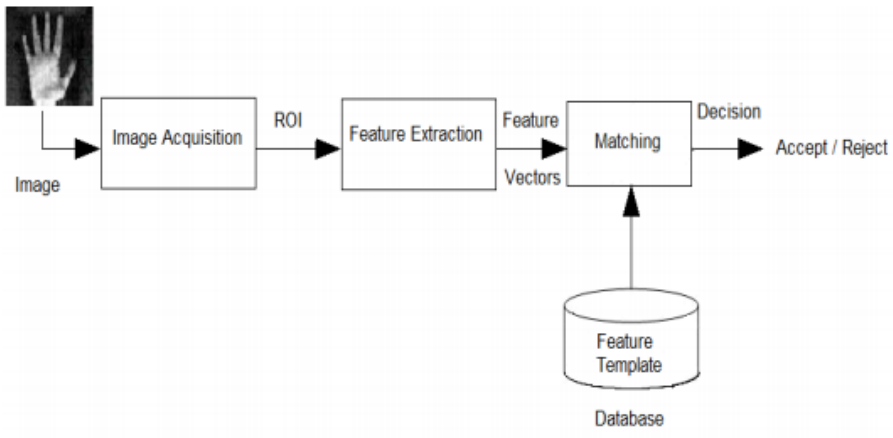

Figure 3: Palm print recognition System

Palm images acquired are pre-processed to extract its features. The principal lines are significant and minutiae and textures are used as unique information in forensic .The pre-processing steps involve converting the image to binary, extracting the region of interest and segmenting, key point detection and establishing the coordinating system. The pre-processing can be summarized as

- Low pass Gaussian filter is applied to smoothen the palm image.
- Binarize the palm image with a proper threshold.
- Apply morphological operations
- Trace the boundary of palm image to identify and fix the key points
- Find the orientation of palm image and find the coordinate system to crop the region of interest.

Extracting the region of interest is carried out using many methods. Centre of the palm is used as the region of interest in many methods as it covers most of the palm features and has a unique texture for each person. To extract the centre of palm image first it has to be aligned and oriented to crop the centre portion. Many methods are used for orientation, like the elliptical method where an ellipse that's fit the boundary of palm is obtained and orientation of palm is obtained by major axis of ellipse. In key point extraction the valley points from middle finger, ring finger, little finger and the line joining these are taken as orientation and a centre portion of palm image is found and a circular or a squared portion of defined size is cropped.

BACKGROUND OF VEINS BASED SYSTEMS

The veins based images like head veins, face veins, palatal veins, heart veins, hand/finger veins and palm images. These images are used for identifying the persons from others. The veins based technique is widely used in these days because these techniques cannot to modified or falsified. The veins of humans are stabled and unique until the human is in the living stage. Any other technique that is not based on vein based recognition system, then an expert person can easily modify the techniques like fingerprints, palm prints, hand shapes and face shapes recognition systems. These techniques do not identify the uniqueness of a person in complex situations. Due to these reasons, the vein based technique has an advent in the field of security systems.

The veins based security system is much more secure than other security systems. At the starting of this technique finger vein based identification system has been used; then palatal based identification system has been used for identifying the individuals. Then after the face vein based technique is a new identification technique which is widely used during these days; because face veins are unique for each person but finger veins, hand veins, palm vein, heart veins might match with other persons. Due to these reasons, face vein based identification system are used. The face vein images are captured by thermal cameras from optical image. After obtaining the thermal image, extraction feature method is used for obtaining the Veins image of a person

A. Why Veins Based Systems?

Vein based identification systems are being widely used these days because other techniques like fingerprints, palm prints, hand geometry, facial expressions, skin color, voice recognition, gait signature, body language, DNA recognition and heartbeat recognition systems are unable in identifying the twin persons. Also, the fingerprint can be easily modified with the help of plastic surgery; and other techniques do not give the appropriate result in the complex situations. Thus, a person cannot be identified due to these reasons. Therefore, veins based techniques are required for identifying the individuals. The vein based technique identification cannot be modified easily, so this technique is widely used during days.

The veins based identification systems takes less space in memory for storing in the database. We can reduce the size of visual images after converting them into vein based identification system. With the help of a database, the image of a person can be matched with database"s image of the person. If both of the images match, then the person will be same, else different.

B. Classification of Veins Based Systems

Veins based identification systems are classified into two categories namely uni-veins systems and multi-veins systems*. In the uni-veins* based system, the veins of the single physiological feature are used for identifying a person. The examples of uni-veins based identification systems are : head, face, iris, palatal, heart, hand, fingers and palm veins based identification systems. *In the multi-veins* based system, the veins of two or more physiological features are used for personal identification.

MULTI-VEINS BASED IDENTIFICATION SYSTEMS

Multi-veins based biometric system uses the combination of two or more veins features based identification system for identifying individuals. Multi-veins based biometric systems are categorized on the basis of combinations of head veins, face veins, palatal veins, heart veins, hand veins, palm veins and finger veins based features. The possible combinations of multi-veins based biometric systems are presented in figure 4.

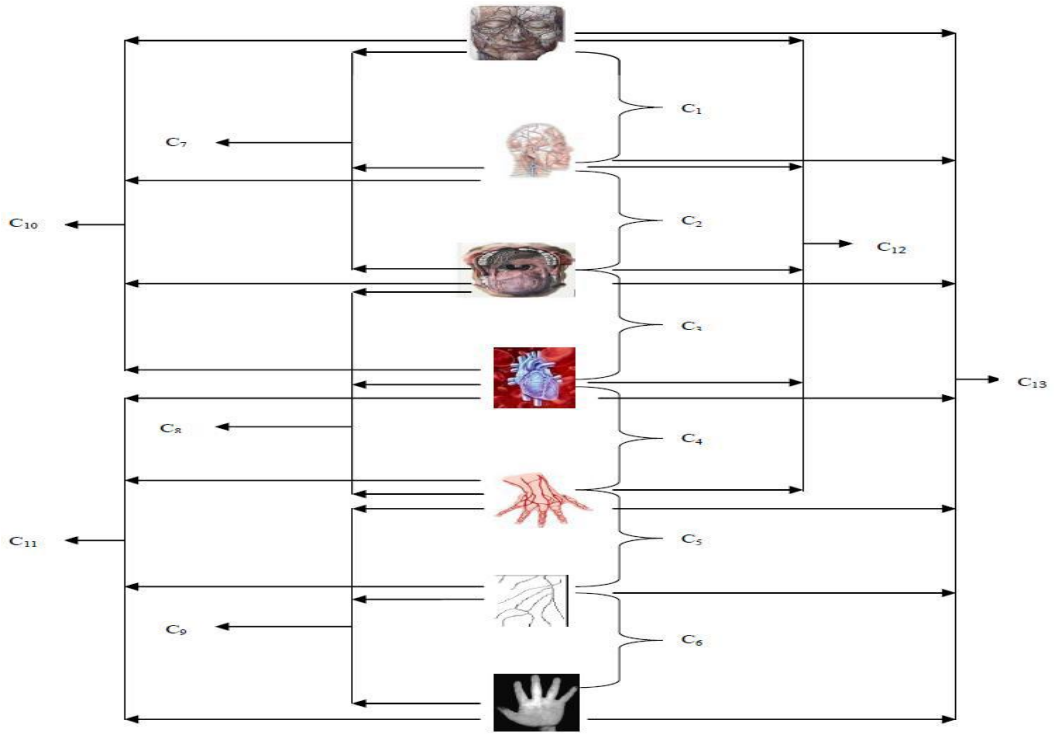

Figure 4: Possible combinations of multi-veins based biometric systems

The possible combinations of two to seven types of veins images and corresponding features based identification systems are: Face and head veins; Head and palatal veins; Palatal and heart veins; Heart and hand veins; Hand and fingers veins; Fingers and palm veins; Face, head and palatal veins; Palatal, heart and hand veins; Hand, finger and palm veins; Face, head, palatal and heart veins; Heart, hand, finger and palm veins images; Face, head, palatal, heart and hand veins images; Face, head, palatal, heart, hand, finger and palm veins images.

OBJECTIVES OF THE STUDY

The objectives of this study aimed at understanding the different types of biometric systems and provide the significance of multimodal systems over other systems. In addition, this study aims at using Palm and Palm Vein for Personal Identification, but before that, the reasons for that will be described. The specific objectives of this study can be enlisted as follows:

- To provide an overview of biometric systems especially multimodal systems.
- To investigate the existing techniques of biometric multimodal systems.
- To discover the proper methodology used in biometric multimodal systems.
- To develop reliable multimodal systems in order to enhance the security and eliminate problems in personal identification systems with high recognition rate.
- To test the validity and performance of the proposed systems with a comparison to such existing systems.
- To give conclusions and recommendations for future works.

METHODOLOGIES

Based on techniques we used the methodologies that lead to a useful result like:

- Image processing methods (Pre-processing, feature extraction, region of interesting)
- Classification and Clustering techniques using ANN, LVQ, SVM, FNN etc.

SIGNIFICANCE OF THE STUDY

Establishing identity is becoming critical in our vastly interconnected society. Questions such as "Is she really who she claims to be?," "Is this person authorized to use this facility?" are routinely being posed in a variety of scenarios ranging from issuing a driver's license to gaining entry into a country. Biometric recognition refers to an automatic recognition of individuals based on a feature vector(s) derived from their physiological and/or behavioral characteristic. Biometric recognition systems should provide reliable personal recognition schemes to either confirm or determine the identity of an individual. Applications of such a system include computer systems security, secure electronic banking, mobile phones, credit cards, secure access to buildings, health and social services. By using biometrics a person could be identified based on "who she/he is" rather than "what she/he has" (card, token, key) or "what she/he knows" (password, PIN).

PROPOSED WORK PLAN

Year-wise plan of work and targets to be achieved

Year 1:

- Literature Survey.
- Theoretical analysis of the existing Techniques of multimodal and biometric systems.
- preprocessing techniques on palm print and palm veins Databases

Year 2:

- Design and implement a multimodal biometric system based on palm and palm veins for personal identification.

Year 3:

- Assessment of experimental results in terms of comparison.
- Interpretation of the experimental results.
- Preparation of final synopsis and thesis.
- Submission of synopsis and thesis.

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